Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

ULTRASPECTROSCOPIC STUDIES ON BLOOD SERUM

II. THE DIFFERENCE IN THE COLLOIDAL STATE OF NORMAL AND IMMUNE SERUM

T. Tadokoro and Y. Nakayama

From the Kent Chemical Laboratory, University of Chicago, and the John McCormick Institute for Infectious Diseases, Chicago

As reported in the previous paper, the antagonistic action of different salts causes a change in the colloidal state of blood serum. The ultraspectroscopic investigation of the serum showed clearly the changes of the degree of dispersion and of the structures of the particles.

In the literature on immunization many reports are found which state that the actions of immune serum are intimately related to the colloidal state of the serum. For example, in the agglutination of blood corpuscles of a number of animals by ricin and other toxins there is a change in the colloidal state of the serum. A curious occurrence which seems to show the toxin-antitoxin reaction to be closely related to colloidal reactions in general is seen in the so-called Danysz[1] phenomenon. Bordet,[2] Joos,[3] have interpreted in different ways the fact that the presence of salt is necessary for agglutination by a serum. The colloidal explanation of the precipitin reaction is most reasonable. Bruck has shown that in the Wassermann reaction a precipitation takes place which is visible under the ultramicroscope. Weichhard's epiphanin reaction, i. e., the diffusion of methylene blue across the tube in which antigen and antibody are present and not in the control, seems to be a method for the determination of the degree of dispersion of blood serum. These interesting observations have prompted a study of the change in the colloidal state of blood serum with an ultraspectroscope. We omit the description of the ultraspecroscope illuminated by a hydrogen lamp and the explanation of the apparatus, because already explained in the previous paper. In this work we took photographs in the same way.

Received for publication Aug. 15, 1919.

[1] Ann. de l'Inst. Pasteur, 1902, 16, p. 331.

[2] Ann. de l'Inst. Pasteur, 1899, 13, p. 225.

[3] Centralbl. f. Bacteriol., I, O., 1903, 33, p. 762.

THE DIFFERENCE BETWEEN THE SERUMS OF DIFFERENT ANIMALS

To examine the difference in the serums of different animals, we used 7 samples of normal serum from different animals: 2 samples from rabbits, 2 from dogs, 2 from guinea-pigs and 1 from a horse; these samples were diluted with distilled water in different concentrations as shown. The photographs were taken and the position of the boundary lines of the absorption bands were measured on the plate. The results are given in table 1.

From these results it can be observed that in the original serum and the 1:2 or 1:4 dilution it was difficult to distinguish between the

TABLE 1

WAVE LENGTH IN MILLIMIKRONS OF BOUNDARY LINE OF ABSORPTION BAND OF NORMAL SERUMS

Concentration of Serum	Wave Length of Boundary Line of Absorption Band						
	Dog Serum		Guinea-Pig Serum		Rabbit Serum		Horse Serum
	A	B	A	B	A	B	
Original	4,275-3,880-3,625-3,360	5,600	5,750	5,750	4,350	5,800	4,250-3,880-3,135
2	4,150-4,050-3,065	5,350-4,950-4,200	5,625-5,125-4,375	5,700-5,050-4,500	4,250-3,950-3,060	5,650-5,450-5,200-5,150-4,350	3,070
4	3,040	4,050-3,965-3,280-3,145-3,085	4,225-3,880-3,450-3,125	5,650-5.350-4,350-3,890-3,500-3,115	4,180-4,052-3,025	4,300-3,900-3,310	3,040
6	.....	.....	.....	.....	4,080-2,985	4,180-4,040-3,020	
8	2,960	3,055	2,985	4,250-3.880-3,065	2,935	2,955	3,020
10	.....	.....	.....	.....	2,915	2,925	
12	.....	.....	2,915	4,180-3,980-2,970			
16	2,930	2,930	2,880	4,180-3,980-2,935	2,860-2,625-2,455	.....	3,990
24	.....	.....	.....	.....	.....	2,890-2,545-2,470	
32	2,810-2,575-2,480	2,850-2,585-2,465	2,425	2,825-2,790-2,425	2,780-2,410	2,840-2,655-2,430	2,955
64	2,425	2,420	2,375	2,410	2,383	2,395	2,925-2,560-2,470
128	2,385	2,365	2,345	2,380	2,359	2,365	2,895-2,615-2,450
256	2,345	2,330	2,315	2,335	2,330	2,325	2,410
512	2,325	2,305	2,280	2,305	2,282	2,295	
1,024	2,280	2,275	2,235	2,255	2,255		

A = straight line; B = dotted line.

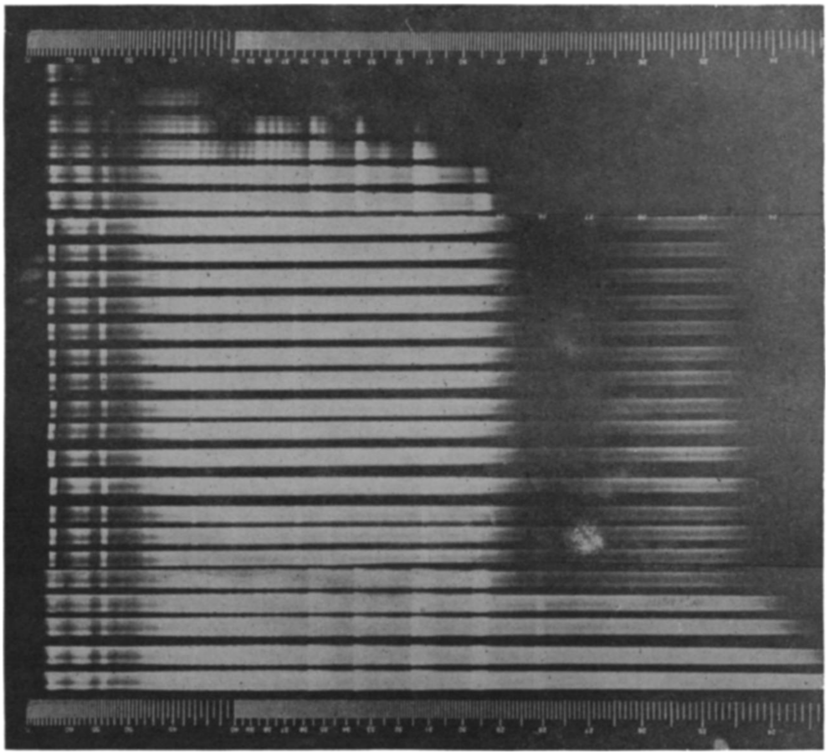

Fig. 1.—The special absorption band between 2,950-2,400 mikrons of normal rabbit serum.

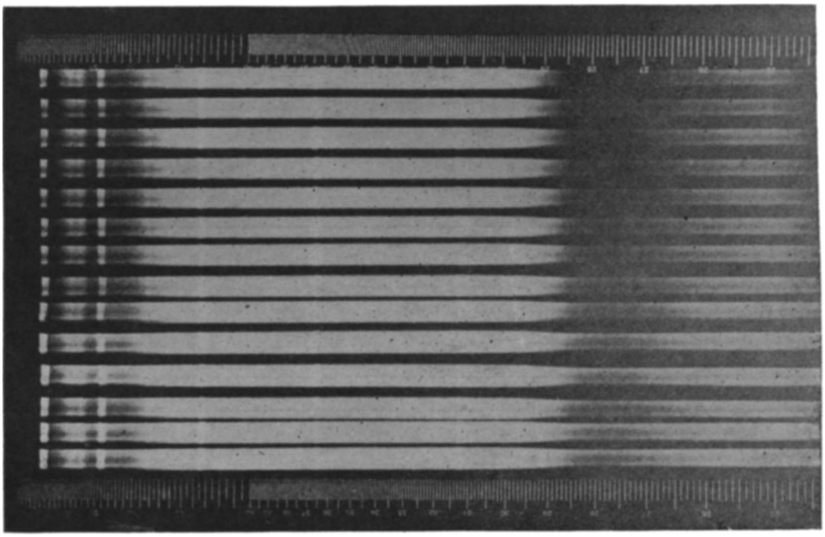

Fig. 2.—Serum of a normal rabbit.

kinds of animals because the absorption band of the serum was influenced by contamination with coloring matter from the blood corpuscles. Therefore we compared the samples between the wave lengths of 2,950 and 2,400 mikrons where every kind of blood serum shows a special absorption band (figure 1).

From the comparison of this part of the spectrum of different samples we observe a clear difference in the position of these absorption bands:

1. Dog serum has a large absorption band in a dilution of 1:32 and the illuminated part of the short wave length is small. Therefore this absorption band appears in a little higher dilution than 1:32 but disappears in a dilution of 1:64.
2. Guinea-pig serum shows this absorption band in solutions between 1:16 and 1:32 dilution, because in the 1:16 dilution, no absorption band is observed and in 1:32 dilution the band almost disappears.
3. Rabbit serum shows this absorption band in 1:16 dilution and it still appears in 1:32 dilution, but it is not continued in still higher dilutions as in the case of the dog, because the absorption band in 1:32 dilution is smaller than the illuminated part.
4. Horse serum shows this absorption band in dilutions of from 1:64 to 1:128 and still higher because the band in the 1:128 dilution is larger than the illuminated part.

THE DIFFERENCE BETWEEN NORMAL AND IMMUNE SERUM

In the next experiment we used immune serums of different animals.

1. Horse, 2 samples of normal and 2 samples of immune antistreptococcus serum.
2. Rabbit, 6 normal and 7 immune serums:
    a. Antistreptococcus serum
    b. Antistreptococcus serum; agglutinin titer, 1,280
    c. Antistreptococcus serum; agglutinin titer, 1,600
    d. Anti-egg serum, precipitin titer, 24,000
    e. Anti-egg serum, precipitin titer, 24,000
    f. Antimilk serum, precipitin titer, 200
    g. Antiplatelet (dog) serum, precipitated in milk dilution, 1:200
3. Dog, one normal and two immune serums:
    a. Antirat serum, agglutinin titer, 1:1;536
    b. Antirat serum, agglutinin titer, 1:3,072

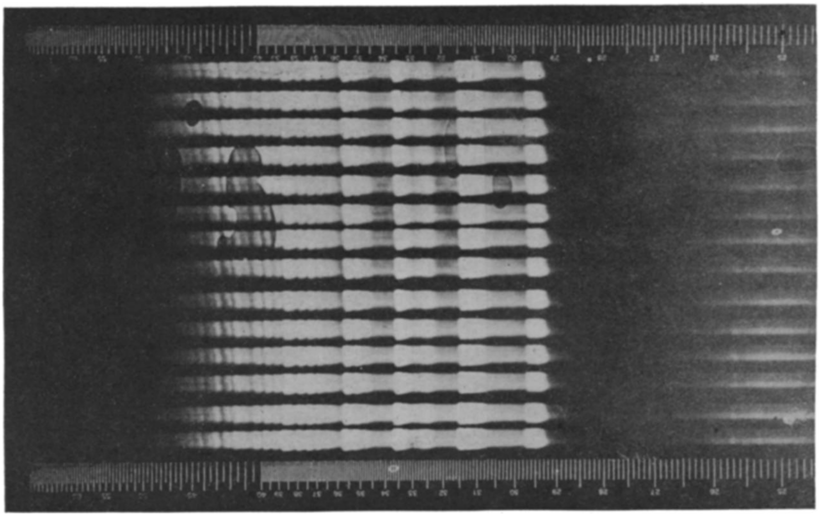

Fig 3.—Serum of rabbit injected with cow's milk.

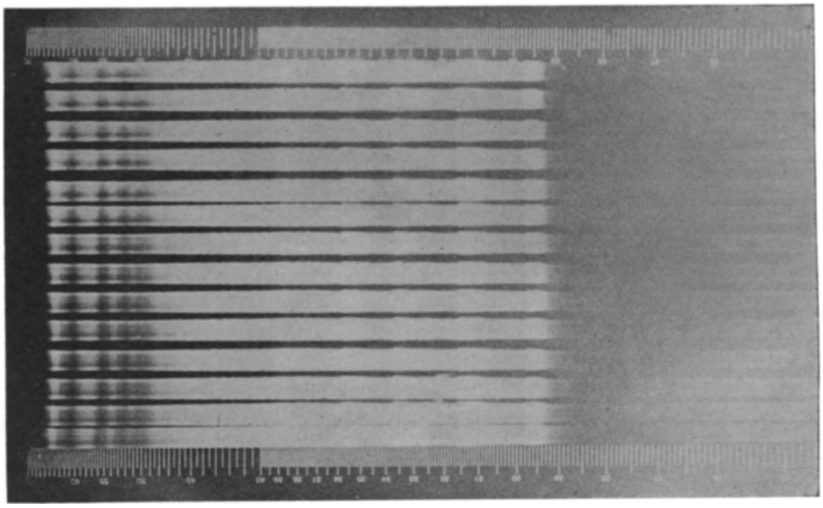

Fig. 4.—Serum of rabbit injected with dog platelets.

To dilute the serum we used always 0.9% sodium chlorid solution and as a preliminary experiment we examined 4 normal and immune serums in different dilutions with results as shown in tables 2, 3, 4, and 5.

TABLE 2

Horse Serum

Concentration of Serum	Wave Length in Millimikrons of Boundary Line of Absorption Band	
	Normal Serum	Immune Serum (Antistreptococcus)
Original	4,500-4,330-3,900-2,620-3,570-3,340	4,625-4,300-3,930-3,610-3,570-3,510-3,350
2	3,105	3,100
4	3,050	3,060
8	3,030	3,030
16	3,005	2,990
32	2,930	2,940
64	2,910-2,510-2,480	2,925-2,510-2,553
128	2,860-2,710-2,480	2,850-2,620-2,425
256	2.400	2,380

TABLE 3

Horse Serum

Concentration of Serum	Wave Length in Millimikrons of Boundary Line of Absorption Band	
	Normal Serum	Immune Serum (Antistreptococcus)
32	2,935	2,955
47	2,930	2,920
70	2,885-2,605-2,455	2,895-2,585-2,470
105	2,810-2,670-2,435	2,875-2,645-2,465
150	2,405	2,850-2,670-2,425
225	.....	2,400

TABLE 4

Rarrit Serum

Concentration of Serum	Wave Length in Millimikrons of Boundary Line of Absorption Band	
	Normal Serum	Immune Serum (Antistreptococcus a)
32	2,925-2,565-2,500	2,980-2,540-2,510
46	2,800-2,600-2,490	2,880-2,585-2,470
69	2,425	2,810-2,710-2,425

TABLE 5

Rarrit Serum

Concentration of Serum	Wave Length in Millimikrons of Boundary Line of Absorption Band	
	Normal Serum	Immune Serum (Antistreptococcus b)
30	2,910-2,501-2,495	2,910-2,610-2,470
36	2,865-2,660-2,455	2,875-2,655-2,455
43	2,795-2,665-2,450	2,810-2,660-2,445
51	2,425	2,765-2,710-2,435
61	2,410	2,410
47	2,395	2,390
89	2,375	2,380

TABLE 6

NORMAL RABBIT SERUM

Wave Length in Millimikrons of Boundary Line of Absorption Band			
Rabbit 1	Rabbit 2	Rabbit 3	Rabbit 4
2,920-2,610-2,480	2,920-2,610-2,460	2,840-2,750-2,460	2,850-2,740-2,445
2,815-2,660-2,480	2,890-2,650-2,450	2,820-2,735-2,465	2,840-2,750-2,445
2,810-2,665-2,460	2,810-2,655-2,450	2,800-2,730-2,465	2,815-2,760-2,435
2,805-2,665-2,460	2,800-2,650-2,450	2,460	2,435
2,805-2,675-2,450	2,800-2,695-2,445	2,455	2,435
2,800-2,675-2,450	2,765-2,715-2,445	2,445	2,435
2,445	2,440	2,445	2,430
2,445	2,440	2,440	2,430
2,440	2,440	2,440	2,420
2,430	2,430	2,430	2,415
2,435	2,427	2,425	2,415
2,430	2,427	2,425	2,410
2,424	2,424	2,425	2,400
2,415	2,408	2,415	2,400

TABLE 7

IMMUNE RABBIT SERUM

Wave Length in Millimikrons of Boundary Line of Absorption Band				
Anti-egg Serum	Antimilk Serum	Anti-egg Serum	Antiplatelet Serum	Antistreptococcus Serum
2,875-2,630-2,430	2,885-2,605-2,445	2,880-2,630-2,455	2,900-2,605-2,459	2,890-2,535-2,465
2,860-2,660-2,430	2,875-2,675-2,440	2,860-2,640-2,445	2,875-2,605-2,455	2,885-2,540-2,460
2,860-2,665-2,430	2,855-2,660-2,430	2,860-2,645-2,445	2,855-2,615-2,455	2,880-2,545-2,455
2,850-2,668-2,425	2,855-2,660-2,430	2,845-2,670-2,445	2,850-2,630-2,450	2,875-2,550-2,455
2,835-2,710-2,422	2,855-2,655-2,425	2,825-2,715-2,440	2,850-2,630-2,450	2,865-2,560-2,455
2,790-2,720-2,420	2,855-2,655-2,425	2,810-2,730-2,440	2,850-2,635-2,440	2,865-2,580-2,455
2,790-2,725-2,420	2,845-2,660-2,420	2,800-2,730-2,440	2,840-2,650-2,435	2,860-2,595-2,455
2,780-2,745-2,420	2,830-2,660-2,420	2,785-2,730-2,440	2,840-2,655-2,430	2,860-2,605-2,455
2,415	2,815-2,665-2,420	2,785-2,740-2,435	2,835-2,670-2,430	2,855-2,605-2,450
2,415	2,815-2,675-2,420	2,430	2,820-2,680-2,430	2,855-2,615-2,450
2,415	2,815-2,685-2,420	2,430	2,805-2,690-2,430	2,850-2,640-2,450
2,415	2,810-2,700-2,415	2,425	2,790-2,600-2,420	2,845-2,650-2,450
2,410	2,805-2,700-2,410	2,420	2,780-2,725-2,420	2,840-2,680-2,440
2,405	2,805-2,700-2,405	2,415	2,415	2,835-2,695-2,440
	2,805-2,705-2,405			
	2,805-2,630-2,405			
	2,805- -2,405			

TABLE 8

DOG, NORMAL AND IMMUNE SERUM

Wave Length in Millimikrons of Boundary Line of Absorption Band		
Normal Serum	Immune (Antirat) Serum	Immune (Antirat) Serum
2,890-2,535-2,465	2,870-2,680-2,460	2,900-2,610-,2480
2,885-2,540-2,460	2,850-2,690-2,450	2,900-2,620-2,460
2,880-2,545-2,455	2,845-2,700-2,445	2,880-2,625-2,460
2,875-2,550-2,455	2,845-2,715-2,440	2,880-2,625-2,460
2,865-2,560-2,455	2,845-2,720-2,435	2,875-2,630-2,455
2,865-2,580-2,455	2,835-2,720-2,430	2,870-2,640-2,450
2,860-2,595-2,455	2,830-2,720-2,425	2,865-2,650-2,445
2,860-2,605-2,455	2,820-2,720-2,425	2,860-2,660-2,440
2,855-2,605-2,450	2,800-2,725-2,425	2,855-2,670-2,440
2,855-2,615-2,450	2,800-2,740-2,425	2,855-2,680-2,435
2,850-2,460-2,450	2,800-2,750-2,420	2,850-2,685-2,428
2,845-2,650-2,450	2,790-2,765-2,420	2,840-2,690-2,425
2,840-2,680-2,440	2,415	2,835-2,690-2,425
2,835-2,695-2,440	2,415	2,830-2,720-2,420

From these results it is seen that the absorption band of immune serum is always larger and longer than that of normal serum. Therefore it is necessary to compare the position of the absorption band of normal and immune serum more exactly and accurately. The two kinds of serum were diluted as follows: one c c of serum diluted to 30.0 c c with 0.9% salt solution and 6.0 c c of this dilution was taken and diluted progressively with 0.25 c c of 0.9% sodium chlorid each time:

(1) 6.0 c c of diluted serum 1.0 c c serum with 29.0 c c NaCl-sol.
(2) 6.0 c c of diluted serum + 0.25 c c NaCl sol.
(3) 6.0 c c of diluted serum + 0.50 c c NaCl sol.
(4) 6.0 c c of diluted serum + 0.75 c c NaCl sol.
(5) 6.0 c c of diluted serum + 1.0 c c NaCl sol.
(6) 6.0 c c of diluted serum + 1.25 c c NaCl sol.
(7) 6.0 c c of diluted serum + 1.50 c c NaCl sol.
(8) 6.0 c c of diluted serum + 1.75 c c NaCl sol.
(9) 6.0 c c of diluted serum + 2.00 c c NaCl sol.
(10) 6.0 c c of diluted serum + 2.25 c c NaCl sol.
(11) 6.0 c c of diluted serum + 2.50 c c NaCl sol.
(12) 6.0 c c of diluted serum + 2.75 c c NaCl sol.
(13) 6.0 c c of diluted serum + 3.00 c c NaCl sol.
(14) 6.0 c c of diluted serum + 3.25 c c NaCl sol.

On the examination of diluted serum by the ultraspectroscope we obtained the results given in tables 6, 7, and 8.

From these results we secure a clear idea of the difference between normal and immune serum. The absorption band of immune serum between the wave length 2,950-2,400 mikrons is much larger and longer than that of normal serum. If we compare both kinds of serums with respect to the area occupied by the absorption band, the area of the absorption band of the immune serum is from two to ten times greater than that of normal serum.

SUMMARY

The difference between the serums of different animals, i. e., dog, guinea-pig, rabbit and horse, was observed in the position and the extent of the absorption band between the wave lengths 2,950-2,400 mikrons.

The absorption band of immune serum between the wave lengths 2,350-2,400 mikrons is much larger and longer than that of normal serum.